REMARKS

Status of Claims

- Claims 1 - 24 are pending.

Amendments to the Claims

- Claims 5, 7 – 10 and 21 are as originally submitted.
- Claims 1 – 4, 6, 11 – 20 and 22 – 24 are currently amended.

Rejections Under 35 U.S.C. §112, 2nd ¶:

Claims 2 and 14 were rejected under 35 U.S.C. 112, 2nd ¶ as the Examiner could not determine the meaning of the recited claim elements: "a mobility world" and "a contact world".

Regarding Claims 2 and 14 (sections 2 through 2.1 of the Office Action):

Applicants respectfully traverse the rejection and submit that the construction of a world module is described in the specification, for example see the summary of the invention on pages 4 and 5, wherein (page 4, line 21) ..."each of the world modules is associated with a proxy module from each meta-module in a group of meta modules associated with the respective interaction phenomenon. The world modules may include, for example, one or more of a communication world, a sensor world, a mobility world, and a contact world...". An exemplary embodiment, that of a world module associated with proximity sensors is described in detail, see for example Figure 4 and the discussion associated with Figure 4, beginning on page 10, line 11. At page 10, line 18, wherein "In FIG 4, world module 420 is associated with proximity sensors. As can be seen, snsble proxy modules 430a-430d and sensor proxy modules 440a-440d are

connected to world module 420 through pointers 423 and may be said to be proxies of the corresponding entities and "belong" to world module 420". Obviously, other modules within the meta-modules can be associated with other world modules, see for example, page 10 line 15, "Some of the modules may further be associated with a given interaction phenomenon and are said to belong to the world module associated with that phenomenon". The modules referred to here include for example, one or more of a communication world, a sensor world, a mobility world, and a contact world, each world module which can be constructed on the basis of the presented exemplary embodiments, and can specifically include mobility world and contact world modules.

Therefore it can be readily determined from the specification that a communications world module can, for example, be associated with one or more communication based modules, for example radio modules, see for example page 19, line 15. Likewise sensor world modules, contact world modules and contact physics modules can for example, be associated with sensor based modules, and a mobility world module can for example, be associated with mobility dynamics modules.

An example of a mobility world module can be found in Figure 5, as described on page 19 at line 20, "Vehicle physics module 560 can reference, for example, terrain database proxy module 510, owned by Terrain world module (not shown) to compute how the associated vehicle would move under a command signal." i.e. as associated with the vehicles mobility. Also see page 26, lines 12-22 and page 27 lines 1-5, describing various embodiments of vehicle mobility modules wherein, "Vehicle Mobility modules typically move a vehicle across a terrain at an ideal bearing and speed determined by its control inputs. For wheeled vehicles, the bearing and speed are

typically reduced from the ideal by referencing terrain mobility characteristic modeled through the environment and height, pitch, and yaw are clamped to the terrain.... Motion of a Robotic All Terrain Lunar Exploration Rover... is computed.... A hopper motion is computed by .... Winged/hovering UAV motion may be computed by..."

Additionally, embodiments of world modules, for example a contact world module, can take advantage of pre-existing collision detection libraries as described, for example, at page 23 lines 9 – 22, and at page 24 lines 19 – 22 wherein "It should be noted that environment models typically provide geometric and related datasets that other modules utilize for sensing and the physical effects simulation. For example, geometry models can be used in conjunction with V-Collide and CSTK to perform polygon-to-polygon intersection tests to determine whether two geometry sets collide." i.e. are contacting. Also see page 29 lines 13-22 describing an exemplary embodiment wherein "collision detection", i.e. contact has been demonstrated.

Applicants respectfully submit that in light of the arguments presented above, the rejection to Claims 2 and 14 be withdrawn.

Rejections Under 35 U.S.C. §101:

Claims 1 – 15 were rejected under 35 U.S.C. 101 as the Examiner asserted that the claims appear to be directed to an abstract idea that is not tangible (see section 4 of the Office Action).

Regarding claims 1 – 15 (sections 3 through 4 of the Office Action):

Applicants have amended base claim 1 to include in the preamble "A method practiced on a computer...", and base claim 13 to include in the preamble "A computer

based apparatus..." to more clearly point out the claimed invention as methods practiced on a computer and computer based apparatus for accommodating interaction phenomena in a data-flow-based simulation of a system of elements. Applicants respectfully submit that the amendment(s) introduce no new matter, and that support for the amendment can be found in the specification as originally submitted, for example, at page 28 lines 18 – 23 and page 29 lines 1 – 3 and 13 – 23.

Applicants respectfully traverse the rejection and submit that the claims are drawn to methods and apparatus providing useful, concrete and tangible results, specifically, methods and apparatus for accommodating interaction phenomena in data-flow based simulations of a system containing multiple elements. The need for, and utility of the inventive method are well known within the art and are described for example, in the section, "Background of the Invention" in the specification as originally submitted, and in the reference "RAVE: A Real and Virtual Environment for Multiple Mobile Robot Systems", Dixon et. al, 1999 Proceedings of 1999 IEEE/RSJ International Conference on Intelligent Robots and Systems, Oct. 17 – 21, 1999, Vol.3, pages 1360 – 1367, see for example the "Introduction" and "Related Work" sections, where for example a utility is expressed as "Investigating sensor configurations in software rather than hardware saves and immense amount of time." and therefore cost to the developer.

Applicants respectfully submit that in light of the amendment and arguments presented above, that the rejection to base claims 1 and 13, and their dependent claims 2 – 12 and 14 – 15, should be withdrawn.

Rejections Under 35 U.S.C. §103:

Claims 1 and 13 were rejected under 35 U.S.C. 103(a) as being unpatentable over Dixon, in view of Buschmann and further in view of Tanenbaum.

Applicants respectfully traverse the rejection, particularly to the claims as amended, and submit the Office has failed to make a prima facie case of obviousness, as the combination of references do not teach all the limitations of Applicants claims 1 and 13. Applicants have amended the language of claims 1 and 13 to more clearly point out the invention, for example, by replacing the original language of the claims "..one or more world modules..." with the phrase "... a plurality of world modules...". Support for this can be found in the specification at page 4 line 21, page 5 line 1 and the Abstract at page 36.

Regarding Claim 13 (sections 6 through 6.4.1 of the Office Action):

Neither Dixon alone nor in combination with Buschmann and Tanenbaum, teaches or suggests all the limitations as recited in claim 13. For example the combination of references do not teach the recited limitation that the instructions comprise "... instructions for causing the processor to establish a plurality of meta-modules, each of the plurality of meta-modules simulating an element in the system of elements...". Nor do the references teach or suggest the recited limitation that the instructions comprise "... instructions for causing the processor to establish a plurality of world modules associated with respective ones of one or more interaction phenomenon such that each of the plurality of world modules is associated with a proxy module from each meta-module of a group of the plurality of meta-modules, the group being

associated with one of the one or more interaction phenomenon, the proxy module from each meta-module of the group forming a grouping of proxy modules...".

The Applicants respectfully submit that the rejection to claim 13 should be withdrawn.

Regarding claims 1 and 13 (section 6.6 through 6.13 of the Office Action):

Neither Dixon alone nor in combination with Buschmann and/or Tanenbaum, teach or suggest all the limitations as recited in claims 1 and 13. For example the combination of references do not teach the limitation recited as "... a plurality of world modules associated with respective ones of one or more interaction phenomenon...". Dixon teaches at page 1364, section 4.1, that a virtual environment consists of a monolithic database, not a plurality of world modules. Dixon teaches: "Real sensor drivers direct queries to hardware, while virtual sensor drivers make the queries into a virtual environment database that is periodically updated by the Environment Manager." This is further illustrated by Dixon in Figure 3, page 1363 and section 3.4 in which "Each robot provides regular position updates to the Environment Manager, which in turn periodically broadcasts the state of the world to all the robots."

The element labeled "real world" in Dixon's Figure 3 is the real world within which the "real robot" operates, and the "real robot's" sensors can sense. The element labeled "real world" in Dixon's Figure 3 is therefore not a module, nor is it a module associated with one or more interaction phenomenon.

In sections 3.2, Dixon teaches the element labeled "GUI server" in Figure 3 "...sends information to the various user interfaces so that they can display the current state of the system consisting of all robots and obstacles". The GUI server does not model interactions among simulated system elements, therefore the GUI server is not a world module.

The teachings of Dixon are directed to methods that are characterized by those skilled in the art, as a modular simulation that uses a "single world" architecture, Dixon's "single world" being embodied in a database, managed by the Environment Manager. Applicants respectfully point out the distinction between Dixon's single world architecture, and the multiple world architecture, as embodied in multiple world modules, and as claimed in the present application. It is to be noted that Applicants implementation of multiple world modules is not a simple duplication or plurality of the prior art. Note that Applicants world modules are, as cited in claims 1 and 13, "... associated with respective ones of one or more interaction phenomenon such that each of the plurality of world modules is associated with a proxy module from each meta-module of a group of the plurality of meta-modules, the group being associated with one of the one or more interaction phenomenon...". One exemplary embodiment of the inventive method as claimed by the Applicants can, for example, contain multiple world modules including a communication world module, a sensor world module, a mobility world module and a contact world module, each of the world modules being associated with, for example, an interaction phenomenon such as communication, sensing, mobility and contact interactions. Each interaction phenomenon being further associated with a proxy module, for example, a communication module (e.g. a radio) a sensing module

(e.g. an acoustic sensor) etc. Therefore, each world module as described and claimed by the Applicants may be differentiated based on the functionality of each of the plurality of world modules. The functionality of a world module is as recited in claims 1 and 13 "... each of the plurality of world modules is associated with a proxy module from each meta-module of a group of the plurality of meta-modules, the group being associated with one of the one or more interaction phenomenon...". Applicants respectfully submit multiple world modules, capable of having differentiated functionality, as recited in claims 1 and 13, are not taught nor suggested by the combined teachings of Dixon, Buschmann and Tanenbaum.

With regards to the cited combinations of Dixon and Buschmann, Applicants particularly direct the attention of the Office to the distinction between Buschmann's definition of a "proxy" and, a "proxy" as defined in the lexicon of the current application. On page 263 Buschmann describes his "proxy" and teaches on page 265 "...Therefore, the proxy offers the same interface as the *original*, and ensures correct access to the *original*. To achieve this, the proxy maintains a reference to the *original* it represents..." (Italics added). In the lexicon of the present application a proxy module is a module that holds data that the world module associated with the proxy module can read and write, see page 10 line 21 through page 11 line 1 of the specification. Applicants proxy module is a part of a meta-module that models a system element. The proxy module as taught and claimed in the present application is not a representative of something else in the simulated system, i.e Applicants proxy is not a representative of a world module or of the meta-module (entity) containing the proxy module. In particular, in Applicants definition of a proxy module, the proxy module is not a copy of an "original". The

Applicants respectfully submit that the combination of Dixon, Buschmann and Tanenbaum do not teach or suggest the elements of claims 1 and 13 including ".... each of the plurality of world modules is associated with a proxy module from each meta-module of a group of the plurality of meta-modules, the group being associated with one or the one or more interaction phenomenon...".

The Applicants further submit that with regards to the cited combination of Dixon and Tanenbaum, Tanenbaum teaches a "time division switch" which redirects inputs into outputs according to a mapping table see Tanenbaum page 139 beginning at second paragraph. Tanenbaum does not teach or suggest that there are or can be interaction(s) between inputs, nor does the combination of Dixon and Tanenbaum teach or suggest a grouping based on an interaction phenomenon as recited in claims 1 and 13 "... the group being associated with one of the one or more interaction phenomenon...". A time division switch as taught by Tanenbaum in combination with the teachings of Dixon and Buschmann, does not teach or suggest a world module capable of modeling interaction phenomena as taught and claimed by the Applicants, see for example page 16 lines 10 – 19 and page 19 lines 15 – 20 wherein "...World modules simulate interaction phenomena in data-flow-based simulation in a manner which is distinguished from conventional data-flow-based simulation systems in that a world module in accordance with the present invention has a special capability or access privilege to read and write certain data of proxy modules associated with it, and has similar access privileges to certain member functions of associated proxy modules. The update function of the world module is responsible for simulating the interaction phenomenon associated with it by exercising these privileges." and, " ... For example, a

Radio Communications world module (not shown) may check a position associated with radio receiver proxy module 530 against positions of radio transmission sources and identify transmission obstacles to determine whether a given signal will reach the receiver. Range sensor module 520 can use geometric analysis techniques to determine whether, for example, an ultrasonic range sensor cone would detect an obstacle." Applicants respectfully submit that the combined teachings of Dixon, Buschmann and Tanenbaum do not teach or suggest that a proxy (or grouping of proxies) is associated with one or more interaction phenomenon.

The Applicants respectfully submit that in light of the amendments and arguments presented herein, that the rejection to claims 1 and 13 be withdrawn.

Claims 3, 4, 10 – 12, 15, 16, and 21 - 23 were rejected under 35 U.S.C. 103(a) as being unpatentable over Dixon and Buschmann and Tanenbaum.

Claims 5 - 9 and 17 - 20 were rejected under 35 U.S.C. 103(a) as being unpatentable over Dixon and Buschmann and Tanenbaum in view of Oualline.

The Applicants respectfully submit that as claims 3 – 12 depend from base claim 1, and as claims 15 – 23 depend from base claim 13, and that as amended claims 1 and 13 are in condition for allowance, the rejections to claims 3 – 23 should be withdrawn.

Regarding claims 3 and 15 (section 7 through 7.1 of the Office Action):

The amendments and arguments presented above (see regarding claims 1 and 13) are applicable to this rejection as well. In addition, Dixon teaches, see page 1362 figure 1 and page 1361, right column, 3rd paragraph: "First is the issue of sensor fusion. Detecting virtual obstacles requires RAVE to have an appropriate model of the real sensor being augmented. Once the virtual component of the sensor computes its reading, this result is then fused with the result from the real component of the sensor and a single reading is returned (refer to Figure 1)." Applicants respectfully submit that Figure 1 of Dixon is teaching a method for fusing data, combining data obtained from real and virtual sensors. The combination of Dixon, Buschmann and Tanenbaum does not teach or suggest the elements as recited in Applicants amended claims 3 and 15, including that one or more of the plurality of world modules is associated with another one or more of the plurality of more world modules.

Applicants respectfully submit that the rejection to claims 3 and 15 should be withdrawn.

Regarding claims 4 and 16 (section 8 through 8.3 of the Office Action):

As noted above (see regarding claims 1 and 13) the cited combination of Dixon, Buschmann and Tanenbaum does not teach or suggest multiple world modules, nor does the combination of references teach or suggest a proxy as described and claimed by the Applicants. It is therefore not apparent at all, how the combination of references could teach or suggest simulating one of the one or more interaction phenomenon in a

corresponding one of the plurality of world modules by accessing one or more member functions in the grouping of proxy modules. Applicants respectfully submit the combination of cited references does not teach or suggest the limitations recited in claims 4 and 16.

Applicants respectfully submit that the rejection to claims 4 and 16 should be withdrawn.

Regarding claims 5 and 17 (section 9 through 9.5 of the Office Action):

Oualline teaches on page 357 creating an element "a new person" of the class "person". Therefore Oualline is teaching creating an element, not a proxy module within an element as claimed by the Applicants in claims 5 and 17 which recite "... dynamically allocate(ing) the proxy module... so as to accommodate the addition of an element in the system of elements being simulated." Referring to Figure 4 of the specification as originally submitted and page 13 lines 1 - 9, "430a" is an example of a proxy module within the meta module comprising the modules 430a, 440a, 450a and 460a, the exemplary meta-module representing the element, a "mobile robot with proximity sensor". Applicants respectfully submit that the combined teachings of Dixon, Buschmann, Tanenbaum and Oualline do not teach or suggest dynamic allocation of a module within a meta-module (or element) as recited in Applicants claims 5 and 17.

Applicants respectfully submit that the rejection to claims 5 and 17 should be withdrawn.

Regarding claims 6 and 18 (section 10 through 10.1 of the Office Action):

Applicants respectfully submit that Dixon, on page 1363, Figure 3, illustrates the architecture of Dixon's teachings, see "Figure 3: Overall architecture of the RAVE framework". The figure illustrates an exchange of information between the Environment Manager and elements, i.e. real and virtual robots, within the simulated system. Applicants respectfully submit that there is no teaching or suggestion in Dixon or the combination of cited references, that results in the limitations as recited in claims 6 and 18, i.e dynamically generating (or for that matter de-allocating) a proxy module by the one or more world modules.

Applicants respectfully submit that the rejection to claims 6 and 18 should be withdrawn.

Claim 24 was rejected under 35 U.S.C. 103(a) as being unpatentable over Dixon and Buschmann and Oualline.

Regarding claim 24 (section 17 through 17.13 of the Office Action):

Applicants respectfully submit that the arguments presented above in support of claims 1, 13 and 7 – 9 are applicable to the rejection of claim 24 as well, and that as the teachings of Dixon, Buschmann and Oualline do not teach or suggest all of the limitations of claim 24, that the rejection to claim 24 should be withdrawn.

Other Amendments:

Claims 2, 3, 4, 6, 11, 12, 14, 15, 16, 18, 22, 23 and 24 have been amended to more distinctly point out the invention as comprising a "plurality" of world modules. Support for this can be found in the specification at page 4 line 21, page 5 line 1 and the Abstract at page 36.

Claims 13, 16 – 20 and 22 - 23 have been amended to more distinctly point out the claimed invention as comprising a memory for storing a set of instructions, a processor coupled to the memory for executing the set of instructions, and the set of instructions including specific instructions as recited in the amended claims. Applicants respectfully submit that support for this can be found in the specification as originally submitted.

CONCLUSION

Applicants respectfully request that the Office reconsider the patentability of the invention in light of the amendments and arguments presented herein, and that a timely Notice of Allowance be issued in this case. The Office is hereby authorized to charge **Deposit Account # 19-0131** for any necessary fees regarding this Reply.

Respectfully submitted,

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